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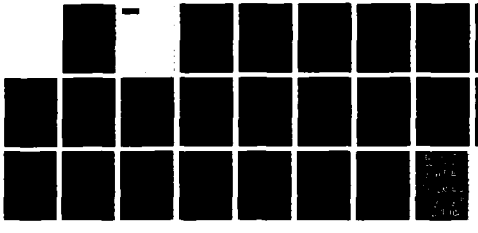

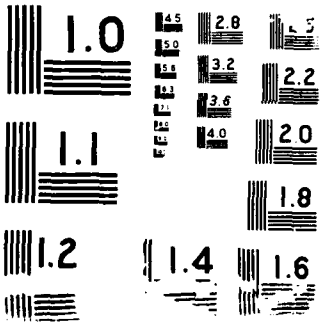
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The Army's ongoing acquisition of modernized Command and Control Communications (C^3) Systems portends a quantum leap in present capabilities. Tremendously expensive, the effort represents a dramatic shift from past procurement policies in as much as it recognizes the need for a systemic, interactive C^3 network that will not only support the Army's Air Land Battle doctrine, but also the C^3 needs of Joint and/or Combined operations. While the acquisition effort is laudable, the author perceives a weakness in the Army's ability to adequately

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manage these new-found resources. Simply put, the capabilities and complexity of existing and soon-to-be fielded systems outstrip the antiquated management techniques used for controlling these vital resources. In order to meet this challenge the author offers a conceptual approach for harnessing our C^3 systems. Key to this approach is the need to accurately recognize the problem. In order to function properly, the new systems must be engineered and installed to meet very preceise and exacting requirements--a need exacerbated by the trend towards increased interconnectivity and interdependence of disparate systems. The answer, therefore, lies in management systems which acknowledge and address this critical need.

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C^2 OF C^3: COMMAND AND CONTROL OF COMMAND, CONTROL, COMMUNICATIONS SYSTEMS

An Individual Study Project
Intended for Publication

by

Lieutenant Colonel William M. Guerra (Author)

Colonel Robert F. Hervey, SC
Project Adviser

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U.S. Army War College
Carlisle Barracks, Pennsylvania 17013
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ABSTRACT

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The Army's ongoing acquisition of modernized Command and Control Communications (C^3) Systems portends a quantum leap in present capabilities. Tremendously expensive, the effort represents a dramatic shift from past procurement policies inasmuch as it recognizes the need for a systemic, interactive C^3 network that will not only support the Army's Air Land Battle doctrine, but also the C^3 needs of Joint and/or Combined operations. While the acquisition effort is laudable, the author perceives a weakness in the Army's ability to adequately manage these new-found resources. Simply put, the capabilities and complexity of existing and soon-to-be fielded systems outstrip the antiquated management techniques used for controlling these vital resources. In order to meet this challenge the author offers a conceptual approach for harnessing our C^3 systems. Key to this approach is the need to accurately recognize the problem. In order to function properly, the new systems must be engineered and installed to meet very precise and exacting requirements--a need exacerbated by the trend towards increased interconnectivity and interdependence of disparate systems. The answer, therefore, lies in management systems which acknowledge and address this critical need.

C^2 OF C^3: COMMAND AND CONTROL OF COMMAND, CONTROL, COMMUNICATIONS SYSTEMS

(or, The Management of Information Systems)

> ...the current and projected lack of a comprehensive battlefield automated C^3 network management system (or system of systems) has had and, until resolved, will continue to have a direct and potentially catastrophic affect on joint and combined forces success on the battlefield. This is a chronic sleeping tiger issue that can and does "eat our lunch" in virtually every passing crisis.
>
> Thomas B. McDonald, COL, USA (ret.)[1]

The U.S. Army is presently in the midst of its most ambitious arms modernization program in recent history. Particularly noteworthy are much needed improvements being made to the Army's tactical command and control communications (C^3) systems. However, in spite of this very significant increase in technical capabilities the Army has not yet realized the full benefit of the new technology--largely because of deficiencies in the operational management of these newly developed resources.

For anyone who reads (and believes) the trade publications such a thesis may be anathema. Descriptives of the new equipment/systems are laden with terms such as 'intelligent', 'self-healing', 'stand alone', etc. One is led to believe that it is merely necessary to turn the equipment on and that the 'logic' of the device will take care of the rest. But, for the

soldier on the ground--the person who actually must put the pieces together and make them work--such a notion is laughable. To that individual the inadequacies of the Army's current management systems and practices are painfully apparent.

The problem is multi-dimensional, but it generally revolves around the issue of command and control of communications (information) resources. Hence, the title of this paper, C^2 of C^3. The objective of this article is to explore the problem, to define and identify components, and to propose a conceptual approach for solution.

There is nearly perfect unanimity in proclaiming the importance of C^3 systems, but there is far less consensus as to the adequacy of the systems that we actually provide. In discussing C^3 and the effective employment of forces, then Chairman of the Joint Chiefs of Staff, General John W. Vessey, Jr., wrote: "Good, reliable C^3 at every echelon of command is essential to the success of our strategy." But, he cautioned, in the same article, "We must strike a balance as we keep pace with opportunities offered by technology....Sophistication shouldn't lead automatically to complexity. We must guard against complexity and against information that overwhelms execution...."[2]

One specific area in which the Army can and must make tremendous gains, is in the 'Control' of its available resources. The term 'Control' can itself have many connotations, but in the context of this article it generally refers to the functions associated with management of a C^3 network. (A better

definition of terms is contained in the following paragraph.) The bottom line is that if the timely provision of information via C^3 systems is ever to be the combat multiplier that it is touted to be, the Army must take a thoughtful look at how it intends to better manage those systems.

Confusion in Terms

It's extremely difficult to define problems without generalized agreement in terminology. In recent times, this need has become even greater as demarcation lines become increasingly transparent. For example, a few years ago there was an acknowledged difference between comm systems and data systems, but today the distinction between a computer and a communications device is, in many cases, virtually indiscernible. Where does the comm line start and where does the data line stop?

In a similar vein, the purist may wish to draw distinctions between the terms communications, information, intelligence, etc. While acknowledging that there are indeed legitimate distinctions, it is not the author's intention to flail the reader with esoteric definitions of each term. Therefore, a working definition of commonly used terminology is included in the chart 1 on the following page.[3]

Targeted Level

Before delving into the specifics of this study, it is also

Command - the lawful authority exercised by a commander over his subordinates by virtue of rank or assignment. It includes the authority and responsibility for effectively managing available resources.

Control - authority which may be less than full command exercised by a commander; includes the process of establishing and attaining objectives to carry out responsibilities. In a Signal sense, also includes those activities associated with the process of management (i.e. - planning, organizing, directing, coordinating, controlling, evaluating, etc.)

Command and Control (C^2) - the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of a mission and/or tasking.

Communications - a method or means of conveying information of any kind from one person or place to another.

Command and Control Communications (C^3) - the means by which C^2 is exercised; it is an integrated system comprised of the doctrine, procedures, organizational structure, personnel, equipment, and facilities which provides authorities at all levels with the information needed to control their activities.

Information - the meaning that a human assigns to data by means of the known conventions used in their representation.

Information Management (IM) - activities that are required to coordinate, plan, organize, analyze, integrate, evaluate, and control information resources effectively.

Information Mission Area (IMA) - the resource requirements and associated information management activities employed in the development, use, integration, and management of information.

System - an interdependent set of regularly interacting resources (doctrine, procedures, structure, personnel, equipment, etc.) designed for use in the conveyance of information between people and/or places.

Network - a combination of various systems whose ultimate utility is similar but which may or may not be operationally interdependent.

CHART 1: Working Definition of Terminology

necessary to clarify the organizational level that is being targeted. At one time, this was a simple distinction: the Signal universe was either tactical or it was strategic--or, 'fixed station', as strategic was commonly referred to. In fact, most U.S. Army Signal officers grew up in one of two tracks; they were either tactical communicators or they were fixed station communicators. As far as equipment is concerned, it was always easy to identify that which was tactical because it was invariably painted greer and its identity was usually preceded by 'AN' (for Army Navy), whereas fixed plant equipment was usually gray and had all kinds of weird designations. Today, those identifying characteristics are no longer sufficient, for either people or equipment. In essence, the distinguishing differences between tactical and strategic communications have also become increasingly blurred. This article will now--hopefully without contradiction--set a framework within which communications systems operate.

Using doctrinal publications as a basis, the U. S. Army War College currently describes three levels of war: the strategic, operational and tactical.[4] Focus of the tactical level of war is primarily at Corps/Division level and below. Its main concern is armed engagement on the battlefield--tactics. The operational level of war is primarily concerned with those activities conducted at Theater Army/Army Group/Corps level. Its scope includes the theater of operations and its preoccupation is the conduct of major operations and campaigns. It should be noted that the corps has overlapping responsibilities--generally, it

can be described as having operational level planning responsibilities and tactical level directional control. The strategic level focuses on operations from a global or theater of war perspective. It is concerned with wars and theater of war campaigns designed to achieve political/strategic aims and goals. To reemphasize, there are areas of 'overlap' within this framework. (Figure 1 on page 7 depicts this framework and the overlapping relationships.) It should also be noted that the above descriptive differs slightly from the framework drawn by communicators. Their description identifies the strategic, theater/tactical, and sustaining base areas.[5] Figure 2, also on the following page, is a depiction of that framework.

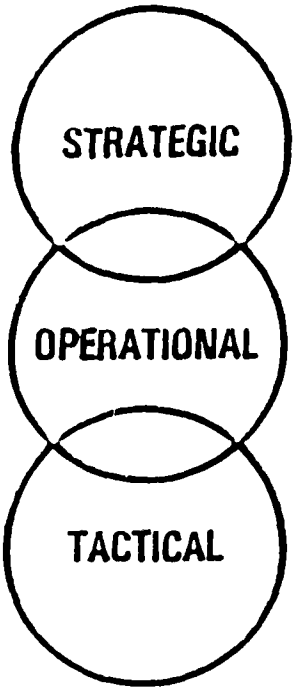
Regardless of the framework used (for the sake of conformity the author prefers the former) the Army's communications systems and networks increasingly overlap these 'boundaries'. Accordingly, the focus in this paper is at the tactical and operational levels since those are the levels at which most of the new systems will be fielded. However, there are implications for the entire spectrum of war.

What's Wrong?

This has been a somewhat lengthy introduction to the problem--but it's one that is necessary. The crux of the issue can be expressed by asking the question, What's wrong with the present methods/systems of managing networks? The simple answer to that question is that the capabilities and complexity of

THE LEVELS OF WAR

FIGURE 1



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ARMY COMPONENT/THEATER ARMY

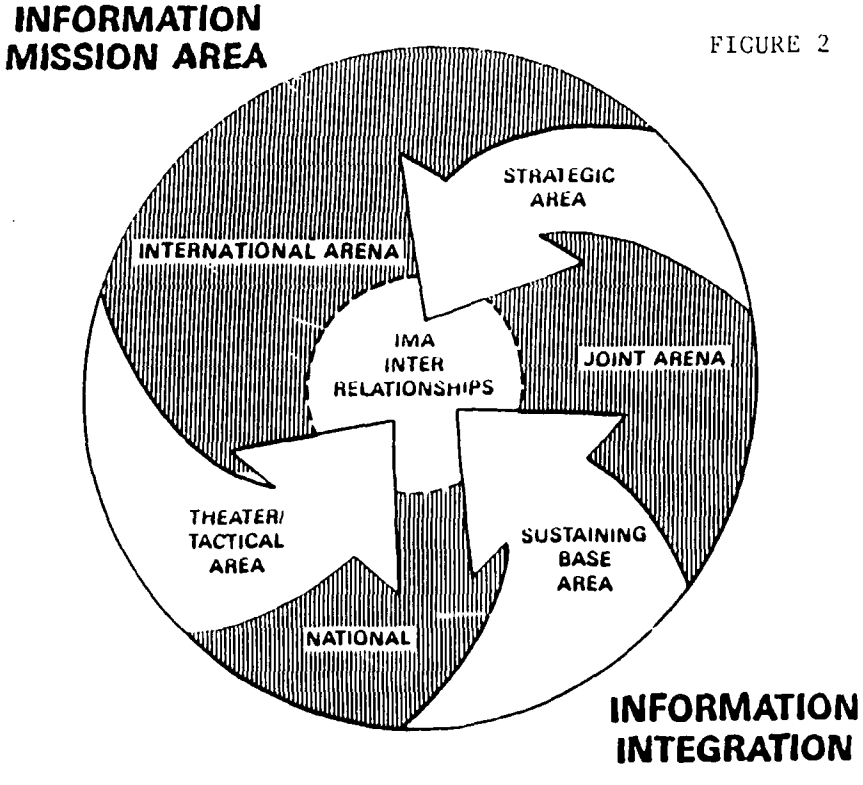
ARMY GROUP

FIELD ARMY

CORPS

DIVISION & BELOW

FIGURE 2



existing and soon-to-be-fielded systems exceed the present capacity to effectively manage those resources.

In the past, the management function--especially at the tactical level--was a comparatively simple task. It was characterized as a stubby pencil drill, often accompanied by repetitive procedures (within set parameters, of course) and it required considerable human interaction.

For example, during the planning phase of an upcoming exercise, wiring diagrams were painstakingly drawn out by the unit's wire chief. After literally hours of labor, the finished product was recorded in that individual's personal notebook or, even worse, in his head. Using analagous methods, the FM network-managers frequently constructed CEOI's by drawing available frequencies or letter/number combinations (for unit callsigns) from a Bingo creel--which was simply their version of a random variable generator. Although crude, these planning techniques worked. The problem with the methodology was that it employed imperfect tools and the cost in terms of time and manpower was excessive.

C^3 management in the operational phase of an exercise was not much better. The principal difference was that stubby pencil mentality had melded with grease pencil technology. With the use of huge, acetate covered charts the system managers attempted to exercise dynamic control over the network by maintaining grease pencil status of circuits, links, systems, etc. This procedure had two serious drawbacks.

The first was that the actual exercise of management

functions was dependent upon observation of the recorded statuses by a knowledgeable individual--hopefully, the controllers themselves but, too often, the next higher level of management, the System Control Officer/NCO or the S3.

The second and equally serious flaw in this system was the related problems of inconsistency in the observed/recorded status and long delays in reporting network problems up through the various echelons of command. There was only minimal assurance that the actual status (of telephones, the switch, radios,...whatever) at any given site had been faithfully reported and accurately recorded at company, battalion and brigade level. And this was the information used by each successive level of command for decision making! Good units and good leaders learned how to cope with this situation. Others--some of them, at least--muddled along.

Control

Progress was inevitable, but it wasn't necessarily fast or dramatic. The advent of the personal computer in the early 1980's resulted in a true revolution in the accepted manner of controlling C^3 networks. Beginning with the rudimentary use of hand held calculators[6] (for the generation of random numbers and compatible radio frequencies) and progressing on to true data base management, the Army was finally making demonstrable progress in the control of networks. Even the use of word processors cut significantly into the monumental task of producing an operations order.

While the use of calculators and PC's signified a marked improvement in management techniques, the fielding to selected units of the Army Tactical Frequency Engineering System (ATFES) represented a quantum leap in capabilities. The main beneficary of the ATFES system was the tactical Signal brigade--and not a minute too soon.

Because of its size and geographical dispersion and also because of the initial fielding of the TRI-TAC automatic switches, the tactical Signal brigades were on the verge of being completely overwhelmed by the management process. With ATFES, these units for the first time had the ability to not only automate some of their more laborious procedures (e.g. - the construction of line-of-sight profiles), they now also had the capability of sharing that information, to include rapidly occurring changes, with subordinate units. At last, units were beginning to see the benefits of operating from a commonly shared data base.

Up to this time Army communicators had only paid lip service to the need for a common data base. After all, what did it matter if the Signal guy or gal on the ground did a little ad-libbing in order to either placate a grumpy subscriber or to 'improve' on the mandated requirements of the operations order? An extra phone here or there, an added drop on the switchboard, the swap of a channel assignment to overcome a local wiring problem, etc, seemed innocent enough.

However, the newly introduced systems--especially the computer based automatic switches-- were far less tolerant of

locally devised engineering (data base) changes. In fact some of the early exercises with the new switches were so frustrating that one high ranking Signal officer complained in a widely circulated (but, unofficial) message that they were better suited for use as boat anchors! Fortunately, as experience with the switches increased so did expertise--as well as an appreciation of the exacting and unforgiving need for a common data base for all sub-elements of the system.

A Need for Precision

Automated devices, particularly voice and message switches, and the communications means with which they interface must meet very precise and exacting requirements. If a switch is programmed to route a call over a primary and a secondary path, it will search for those routes and no others. There is no human operator to say "Well, I couldn't get through those two ways, but maybe I can route you through Divarty's board."

An even worse--and more likely--vulnerability of the new systems is that one of the literally dozens of cable connections, switch settings, and/or equipment components that are a necessary part of every successful attempt to use the system, may be faulty. As a result, part or all of the system may be incapacitated or degraded due to either error (by the engineer or the operator) or due to a physical breakdown somewhere along the electronic path. Obviously, it's the business of the Signal officer to recognize these realities and to make the systems

work. The noteworthy point to be made at this juncture is that the new systems require a far greater degree of precision in their engineering, installation, operation, and reconfiguration than at any time in the past. The obvious conclusion: There is a dire need for a better means of managing these systems.

Command

This article has thus far focused on the control of systems. At this point it would be helpful to integrate the reader's attention to the Command aspect of the discussion. Sometime in the early to mid-1980's, the Army recognized that newly fielded systems were presenting ever increasing problems in terms of control (management, if you wish). However, recognition of the problem did not imply its solution, especially after adding in the human factor.

In order to appreciate this factor one must appreciate the Army's philosophical ideal of firm and positive leadership. Often heard sayings such as "Make a decision, Lieutenant, any decision!" or "When in charge, take charge!" exemplify the spirit of that indoctrination. But for some old-timers the validity of that philosophy was being indirectly challenged by new realities.

The concept of centralized control, decentralized execution has long been an Army maxim, however, the first part of that maxim was, in the view of many, now being given undue emphasis. The reader must understand that up until this time the inter-

dependence between different echelons was comparatively slight and could be accomplished with minimal coordination. As a result each commander ran a fairly autonomous operation. Because of this operational methodology, each commander was acutely aware of the boundaries to his fiefdom. Each knew the specific tasks/conditions/standards that applied to his piece of the pie, and the minimal responsibilities he held for inter-connecting his system to the greater network.

The fielding of the first automatic switches in the early 1980's grossly upset this neat accommodation. Why? Because of the previously mentioned requirements for precision, connectivity and inter-dependence. The practical effect of these requirements was that the manager of each system within the greater network became a key player. It was this individual, organizational lines notwithstanding, who declared the detailed manner in which each sub-element of the system would be run. Every phone, every channel, every pin setting was engineered and dictated to a unit, in the operations order, by the systems manager. Further, after the system was installed and operating, it was still the systems manager who made the critical decisions.

To commanders who had grown accustomed to the relative autonomy of running their own system, but who were now subjected to compliance with the precise directions of the systems manager, the new procedures were an outrageous attempt to usurp their leadership prerogatives. Illustrative of this situation was an incident that occurred during an exercise in which the systems manager, a junior ranking individual serving on a Brigade staff,

found it necessary (because of time and circumstances) to call directly into one of the voice switches to extract information and to pass on directives. In doing so, this individual unwittingly bypassed the command elements of the battalion and the company. Upon learning of the incident, the Battalion Commander, flushed with anger confronted his boss and basically stated "If you want to do business that way, I might as well go home! I'm not even needed!" Predictably, the brigade commander sensitized his subordinate to the new realities vis a vis the management of C^3 networks.

The preceding anecdote is a true one. The story is related here because it summarizes many of the newly recognized realities with which commanders must cope:

- There is greater connectivity and inter-dependence between the various components of C^3 systems.
- To function properly, there is need for great precision in managing (planning, installing, operating, etc.) these systems.
- Management of the systems is becoming increasingly centralized--of necessity.
- Management decisions/information must be passed between the decision makers and the actual executors of those decisions as quickly as possible.

These, then, are the trends with which communicators must deal. The principal implication for commanders is that they must acknowledge the need for an increased and more pervasive type of management--to include, where necessary, the concession of

previously held prerogatives and/or the acceptance of new responsibilities. In order to update the discussion, however, some related observations regarding soon-to-be fielded systems are pertinent.

Related Observations

The first observation is that the trend towards increased centralization of management is likely to become even greater in the future. The new, Mobile Subscriber Equipment (MSE) system presently being fielded at Ft. Hood partially illustrates this need.[7] For the first time in its history, the Army will have a truly integrated, tactical voice network for use within the corps. This article has alluded to the management challenges that implies for the corps' communications element, the Signal brigade. Carried a step further, though, is the implied management mission when multiple corps must operate together.

In the European theater the U.S. 5th and 7th corps operate side-by-side. The senior operational headquarters for those two units is NATO's Central Army Group (CENTAG)--but, significantly, the MSE architecture will not extend up to CENTAG's level. Does this mean that the senior headquarters can therefore rid itself of its management responsibility by simply delegating the authority to subordinate units? Absolutely not! Even though the MSE architecture will not extend to its level, the bonds of connectivity between CENTAG (which will have the TRI-TAC architecture) and subordinate commands are stronger than ever.

In summary, the Army Group's headquarters (CENTAG), which is basically concerned with the strategic and the operational levels of war, will necessarily be involved in the management of the entire Army Group's voice network, extending all the way down to subordinate divisions--which are very much involved with the tactical level of war. (However, the sophistication of the new equipment will help abrogate some of this implied responsibility.) In fact, an analagous situation already exists with present day equipments for both voice and message switched systems.

The second observation is that while the new systems are creating a breed of super controllers, that cadre is a very small one. As stated, the intricacies and nuances of the new systems are driving the need for detailed, centralized management. The result is that those management (control) skills previously practiced at every echelon of command are beginning to atrophy. Obviously, this is a trend which must be avoided and one which will be discussed in greater detail in a later segment of this article.

The third observation is that this article has demonstrated a preoccupation with switched voice systems. This is partially because it is the more prevalent and widely used C^3 system and partially because it is the one with which the author is most familiar. However, the reader would be misled if he were to believe that a revamp of our present (voice systems) control procedures is all that is required. The Sigma Star illustrated in Figure 3 on the following page is a graphic depiction of the

many computer-based, information systems scheduled for introduction to the Army's inventory during the next decade.[8] Some of these systems will be user owned and operated, but many will inevitably come under the centralized management purview of the greater Signal community, therefore, any analysis of C^3 systems management must include a wider horizon. The management of those systems must be integrated so that the emphasis is for development of a C^3 NETWORK management capability and not a plethora of subsystem functionaries.

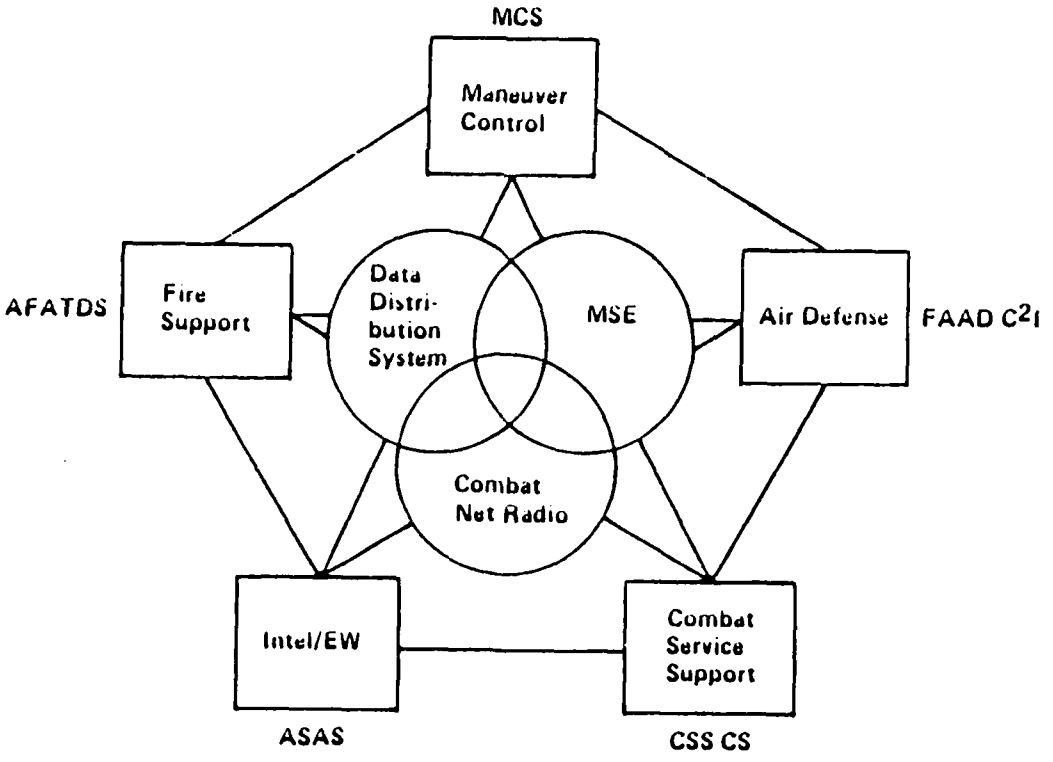


FIGURE 3: The Sigma Star

A Definition of Needs

With the groundwork that has been presented, this article will now concentrate on a better definition of the specific needs for the new systems. As categorized by the author, there are six functional elements that are critical to the C^3 management process, in contrast to the four elements in Army doctrine.[9]

- Planning
- Engineering
- Controlling
- Reconfiguration
- Data Base Management
- Software Management

Others may wish to either consolidate or expand some of the above functions, making an either greater or lesser number. The objective, however, is not to attain an ideal number of categories; rather, it is to ensure that all critical management activities are considered and included. Therefore, a brief description of the above listed functions is apropos.

Planning. The planning function of any network management system should address the basic W's: Who (are the players); What (are the requirements); When (are they required); and Where (is the operation taking place). Chronologically, the planning function represents the start phase of a mission.

Engineering. After the basic requirements have been established, the engineering function helps answer the How (to execute). It involves the detailed mechanics of constructing

systems and networks. Included in this process would be the construction of line of sight (LOS) profiles (for the selection of viable communications sites); the determination of an appropriate analog/digital/hybrid mix of carriers; the sizing of trunk groups; assignment of terminal equipment; etc.

Controlling. Up to this point, the word control has been used almost synonymously with the overall management process. More specifically, it is the element that gives order to the execution of a plan. In this context, however, there are two levels of control, systems control and technical control. Both come into prominence after the planning and engineering functions are completed and both are concerned with the execution phase of a mission/tasking--to include the sub-phases of installation, operation, and sustainment. In this regard, systems control can be likened to a conductor leading a symphony; the controller orchestrates the effort of all those involved to ensure that the end product is a harmonious match of requirements to resources. His most critical role is to 'see' the network, via real time monitoring, and to prevent any actual or potential degradations. Technical control is also a subordinate element of the overall control function. It involves the more precise procedures of monitoring and responding to deficiencies in the network.

Reconfiguration. Because of the intended use of C^3 systems, the support of war fighting forces, the probability of reconfiguring a network is extremely high. Consequently, the ability to rapidly restructure is a vital function of management. It differs from the preceding description of control inasmuch as

it implies a necessity to simultaneously plan, engineer, and execute a reconstruction of part(s) of the network on an immediate basis. This need not imply a catastrophic nor a destructive blow to the network; the need for reconfiguration may be due to a realignment of friendly forces, accommodation of a deep offensive thrust, etc.

Data Base Management. Each unit will undoubtedly have a requirement to create, use, modify, and store both common and unique data base elements. The unit's ability to effectively perform this management function has a direct impact on its responsiveness in executing all of the preceding functions. Without appropriate emphasis in this area a communications unit would essentially start every support mission as if it were a first time event and build from there.

Software Management. Because of the sheer number of C^3 equipments that are either themselves computer based or that require the output of a computer device, the management of the supporting software is certain to be a major challenge, especially when one considers the dynamic nature of the future battlefield. If one adds to this the generation, control, and distribution of key variables for COMSEC equipment, that challenge is even further magnified.

Other Considerations

Any attempt to conceptualize the objective C^3 management element, must necessarily look beyond the above mentioned

functions. There are other considerations that must be included in the envisioned Command and Control element because they are, in present systems, either not present or inadequate to their need. Among the most obvious are the seven 'requirements' listed below:

1. Regardless of the system that is ultimately selected and/or developed, the most obvious need is that that system be one that is computer based. The complexity and interdependence of future (and even present) networks is simply too vast to control by using manual techniques. As already implied, there is cognizance of this need, but it appears that a significant amount of the previously mentioned functions are viewed as anomalies that can still be handled 'off line' using the old manual processes. The need for a computer based system to control a computer based C^3 network may seem obvious, but the constraints for developing a functional, integrated system are substantial, as will be seen in the succeeding paragraphs.

2. The objective control element should be a true network management system. In other words, there is need for a device with which we can effectively manage all of the systems within the greater network. The trend at this time is quite the opposite. If left to their own 'stovepiped' developmental schemes, new systems entering the inventory may all be fielded with separate and distinctive control mechanisms. Conceivably, the commander of the C^3 resources within a unit may have individual control cells for MSE, SINCGARS, EPLRS, JTIDS, etc. In the words of BG Alfred J. Mallette, deputy commandant of the U.S.

Army Signal School, what we are essentially doing is exchanging "swivel chair control" for "tailgate control".[10] (The insinuation being that the system controller will need to hop between the tailgates of various system control shelters in order to execute his functions--as opposed to the current system in which he swivels in his chair between computer terminals clustered about him.) Neither method is adequate. The real thrust should be to consolidate disparate control activities and assign them to a single management element. This is certainly much easier said than done. The most basic obstacles for a computer based system--compatible hardware and software--make this 'requirement' one that will be tough to execute, but one that is nonetheless critical. Somehow, the final product must allow for a single C^3 manager who is capable of integrating the management of all the architectural sub-elements within his unit.

3. In order to develop an integrated management capability, there is an urgent need to develop relational data bases. As C^3 systems themselves become more integrated, the systems manager must have the means of viewing all of the interrelated elements of the network. The impact of the loss of a crypto unit, for example, may degrade a carrier system which is, in turn, manifested by an inability of the commander to use his mobile radio. The systems controller must have an immediate appreciation of that fact--by means of an alarm, a message flashed on his screen, etc--and he must have immediate awareness of the consequences to the greater system of that single downed

unit. That will only happen if the objective management system includes a capability to accept and process related data bases.

4. In order to respond to problems, one must first know that a problem exists. Under current methodology the individual who first detects a problem in the network is often the communications subscriber. In some cases, the actual degradation has existed for hours and does not become apparent until the critical juncture of an exercise. The Signal Officer then becomes the embarrassed recipient of such news and must then, after the fact, initiate corrective actions. The problem, of course, is the one mentioned earlier in which the control element is often blind to the true status of the network. Using present procedures, controllers must rely on the transmission, often through various echelons of management, of reports and records to 'see' the network. The need, then, is for a means of sampling the network on a nearly continuous and on a near real time basis, i.e. on-line telemetry. A positive development in this area is that newly fielded equipments are becoming increasingly capable of flagging problems; however, if those problems are not transmitted to the decision makers that capability is of only limited value. That situation is seen time and again with the new automatic switches. The computer senses a problem, prints it out or flashes it onto the operator's screen--only to be overlooked or ignored.

5. An extremely critical ingredient of the objective system is that the overall controlling functions must be replicated in several locations throughout the network. The

rationale is obvious: In order to maintain a survivable network there can be no single, indispensable nerve center. In the event of loss of the primary control element, the ability to assume, or to resume, management of the network from several alternative locations must be an imbedded feature of the system. In today's schema, that capability is basically non-existent. Under the most optimistic conditions, it would be a matter of hours, if not days, before effective control of the network could be resumed. Part of the problem lies in the presumed loss of the hardware and software tools associated with the control element. Perhaps an even bigger obstacle, however, is the potential loss of the system 'technocrats' referred to in an earlier portion of this article. These individuals are highly skilled in the complex process of piecing the system together; and while their counterparts at lower echelons are usually well versed in subordinate roles, they generally lack an appreciation for the intricacies of creating and managing the greater, composite network. In order to be survivable, therefore, those management procedures and personnel vital to the controlling function must be replicated, and exercised, at several locations throughout the network.

6. Another feature which must be incorporated into the objective system is an ability for decision makers to have <u>accessible control</u> of the network. This is not meant to suggest that physical manipulation of the network (via remote controls) and/or disregard of the established organizational structure is the desired solution. The point is that without a timely means

of implementing management's decisions, all of the benefits gained from telemetry, relational data bases, etc, are effectively negated. Obviously, there are significant equipment and procedural issues which must be resolved before this feature can be incorporated.

7. The final 'requirement' for a conceptualized system is a rather obvious one. It must accommodate the needs of the users. Unfortunately, one who has served in tactical units often comes to the pessimistic conclusion that newly introduced systems are developed with only minimal consideration given to very practical needs. The problem is that although a basic requirement is usually generated from the field it goes through too much of the developmental process without additional feedback from the intended users. Consequently, the first time the users view a new device/equipment/system is when it is brought to the field for operational testing. By that time, the investment that has been expended precludes anything other than the most minor modifications. Although this situation is a generalization, it appears to be particularly true of the manner in which operational software is developed. The typical scenario finds newly released software introduced to the using unit immediately before a major exercise--often resulting in a long, painful series of mishaps before the software is adequately 'debugged' for usage.

Summary.

The Army's present C^3 capabilities are far greater than at any time in the past and they will soon become even better. The ability to literally package and transport modern, ruggedized computer technology to field environments is one of the principal reasons for this explosion in capabilities. But while this newly felt explosion is revolutionizing the Army's C^3 structure, commanders and other warfighters are being deprived of the full benefit of these systems because of a failure to develop and include a commensurate management element along with the newly fielded systems. As COL McDonald asserts "A battlefield comnmand, control and communications (C^3) network management (C^3NM) capability does not currently exist in any of the services, much less on the joint battlefield."[11] The Army is only now, almost a decade after the fielding of the first automatic switch, gaining a real appreciation for the growing problems in C^3 network management. The ATFES system and a soon-to-be fielded interim system are belated recognition of the scope of the management probems that already exist. As other C^3 systems begin to arrive, the mangement problem will become even worse.

The thesis presented in this article is that the Army must immediately redirect its efforts in this critical area. Such an approach demands thoughtful analysis of not only present and projected capabilities, but also a return to the basics. That is, what does the management function entail, what are the

critical sub-functions, what are the anticipated prerequisites of the objective systems and what other features must the objective system possess. This article has attempted to answer those conceptual requirements. Since most of the management systems slated for future fielding are still in the developmental stages, there is still time to acknowledge the conceptual needs addressed in this article.

ENDNOTES

1. Colonel Thomas B. McDonald III, USA (ret.), "Management of Battlefield C^3 Networks: A Personal Perspective," Signal, August 1987, p. 65.

2. General John W. Vessey, Jr., "Command Effectiveness and C^3," DEFENSE 83, November, pp. 2-7.

3. The definitions in Chart 1 are adaptations extracted from the following sources: Joint Chiefs of Staff Publication 1, Definition of Military and Associated Terms, 1 June 1987; U.S. Army Field Manual 100-5, Operations, May 1986; U.S. Army Field Manual 101-5-1, Operational Terms and Symbols, October 1985; U.S. Army Field Manual 24-1, Combat Communications, 11 September 1985; U.S. Army Field Manual 24-22, Communications-Electronics Management Systems, 30 June 1977; and U.S. Army Regulation 25-1, The Army Information Management Program, 1 March 1986.

4. U.S. Army Field Manual 100-5, Operations, May 1986, p.9

5. U.S. Army Regulation 25-1, The Army Information Management Program, 1 March 1986, Para. 2-3 and Fig. 2-2.

6. Major Charles B. Giassson, " The HP-41C: Convenient Responsive," The Army Communicator, Summer 1982, pp. 58-59.

7. GTE Government System Corporation, Mobile Subscriber Equipment (MSE) System Material Fielding Plan, 17 July 1986,

8. Jim Coghlan, "Integrating Battlefield C^3I," Defense Electronics, June 1982, pp.85-103.

9. U.S. Army Field Manual 24-22, Communications-Electronics Management System, 30 June 1977, fig. 2-3, pp. 2-5.

10. Brigadier General Alfred J. Mallette, deputy commandant, U.S. Army Signal Center and School, undated letter, Subject: Integrated Network Management System (INMS) and the Objective CSCE Software.

11. McDonald, p. 61.

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